Department of Transportation
Federal Aviation Administration
Aircraft Certification Service
Washington, D.C.

TSO-C47a

Effective
Date 08/08/06

Technical Standard Order

Subject: FUEL, OIL, AND HYDRAULIC PRESSURE INSTRUMENTS

1. PURPOSE. This technical standard order (TSO) is for manufacturers of fuel, oil, and hydraulic pressure instruments, applying for a TSO authorization or letter of TSO design approval (LODA). In it, we (the Federal Aviation Administration, or FAA) tell you what minimum performance standards (MPS) your aircraft pressure instruments must first meet for approval and identification with the applicable TSO marking.

2. APPLICABILITY. This TSO affects new applications submitted after its effective date.

a. All prior revisions to this TSO are no longer effective. Generally we will not accept applications after the effective date of this TSO. However, we may do so up to six months after it, if we know that you were working against the earlier MPS before the new change became effective

b. Fuel, oil, and hydraulic pressure instruments approved under a previous TSO authorization may still be manufactured under the provisions of their original approval.

c. Major design changes to fuel, oil, and hydraulic pressure instruments approved under previous versions of this TSO require a new authorization. See Title 14 of the Code of Federal Regulations (14 CFR) § 21.611(b).

3. REQUIREMENTS. New models of fuel, oil, and hydraulic pressure instruments identified and manufactured on or after the effective date of this TSO must meet the requirements in this TSO and the requirements explained in SAE International's Aerospace Standard (AS) 408C, *Pressure Instruments - Fuel, Oil and Hydraulic*, dated July 1, 2001.

a. Functionality. This TSO's standards apply to fuel, oil and hydraulic pressure instruments used for all aircraft.

b. Failure Condition Classification. Failure of the function defined in paragraphs **3** and **3.a** of this TSO is a *major* failure condition. Develop each fuel, oil, and hydraulic pressure instrument to, at least, the design assurance level matching the failure condition classification of the system in which it is installed.

c. Environmental Qualification. Test the fuel, oil, and hydraulic pressure instrument according to SAE AS408C section 7, and RTCA, Inc. document RTCA/DO-160E, *Environmental Conditions and Test Procedures for Airborne Equipment*, dated December 9, 2004 or the most current revision. For changes and exceptions, see appendix 1 of this TSO.

d. Software Qualification. If the fuel, oil, and hydraulic pressure instrument includes a digital computer, develop the software according to RTCA/DO-178B, *Software Considerations in Airborne Systems and Equipment Certification*, dated December 1, 1992 or the most current revision. For software developed before RTCA/DO-178B, Section 12.1.4 shows a way to upgrade a baseline for software development so you can make changes according to RTCA/DO-178B criteria. The software design assurance level should be consistent with the failure condition classification in paragraph **3.b** of this TSO.

e. Electronic Hardware Qualification. If the fuel, oil, and hydraulic pressure instrument includes a complex custom micro-coded component, develop the component to the guidance in FAA advisory circular (AC) 20-152, *RTCA, Inc. Document RTCA/DO-254, Design Assurance Guidance for Airborne Electronic Hardware.* The hardware design assurance level should be consistent with the failure condition classification defined in paragraph **3.b** of this TSO.

f. Deviations. We have provisions for using alternate or equivalent means of compliance to the criteria in the MPS of this TSO. If you invoke these provisions, you must show that your fuel, oil and hydraulic pressure instrument maintains an equivalent level of safety. Apply for a deviation under 14 CFR § 21.609 before submitting your data package.

4. MARKING. Mark at least one major component permanently and legibly with all the information in 14 CFR § 21.607(d) and SAE AS408C, Section 3.2 (except paragraph 3.2.b).

a. Mark "Fire resistant" or "Fireproof" information legibly and permanently.

b. In addition to the requirements of 14 CFR § 21.607(d), mark the following permanently and legibly marked with at least the name of the manufacturer, manufacturer's sub-assembly part number, and the TSO number:

(1) Each component that is easily removable (without hand tools),

(2) Each interchangeable element, and

(3) Each separate sub-assembly of the article that the manufacturer determines may be interchangeable.

c. If the component includes a digital computer, then the part number must include hardware and software identification. Or, you can use a separate part number for hardware and software. Either way, you must include a means to show the modification status.

> **NOTE:** Similar software/hardware versions, approved to different software levels, must be differentiated by part number.

d. If applicable, identify deviations granted to the article by marking "Deviation. See installation/instruction manual (IM)" after the TSO number. You can abbreviate the marking to "(Dev. See IM)."

e. Optional marking is permitted to allow the use of aircraft specific or operational specific installation limitations, such as: **"FOR USE ON {insert aircraft type or serial number} ONLY,**" or **"FOR USE ON AIRCRAFT USED IN PART {insert number} OPERATIONS ONLY,"** or **"SEE DRAWING NO. XYZ FOR INSTALLATION LIMITATIONS."**

5. APPLICATION DATA REQUIREMENTS. As a TSO manufacturer-applicant, you must give the FAA aircraft certification office (ACO) manager responsible for your facilities a statement of conformance, as specified in 14 CFR § 21.605(a)(1), and one copy each of the following technical data to support our design and production approval. (Under 14 CFR § 21.617(a)(2), LODA applicants submit the same data through their civil aviation authority:)

a. Operating instructions and equipment limitations in an IM, sufficient to describe fuel, oil and hydraulic pressure instrument operational capability. Describe any deviations in detail. If needed, identify equipment by part number, version, revision, and criticality level of software, classification for use, and environmental categories.

b. Installation procedures and limitations in an IM, sufficient to ensure that the fuel, oil and hydraulic pressure instrument, when installed according to the installation procedures, still meets this TSO's requirements. Limitations must identify any unique aspects of the installation. Finally, the limitations must include a note with the following statement:

> The conditions and tests for TSO approval of this fuel, oil and hydraulic pressure instrument are minimum performance standards. Those installing this fuel, oil and hydraulic pressure instrument, on or in a specific type or class of aircraft, must determine that the aircraft installation conditions are within the TSO standards. TSO articles must have separate approval for installation in an aircraft. The fuel, oil and hydraulic pressure instrument may be installed only according to 14 CFR part 43 or the applicable airworthiness requirements.

c. Schematic drawings of the installation procedures.

d. Wiring diagrams of the installation procedures.

e. List of components, by part number, that make up the fuel, oil, and hydraulic pressure instrument complying with the standards in this TSO. Include vendor part number cross-references, when applicable.

f. A component maintenance manual (CMM) covering periodic maintenance, calibration and repair, for continued airworthiness of the installed fuel, oil and hydraulic pressure instrument. Include recommended inspection intervals and service life. Describe the details of deviations granted, as noted in paragraph **5.a** of this TSO.

g. Material and process specifications list.

h. The quality control system (QCS) description required by 14 CFR §§ 21.143 and 21.605(a)(3), including functional test specifications. The QCS should ensure that you will detect any change to the equipment that could adversely affect compliance with the TSO MPS, and reject the item accordingly. (Not required for LODA applicants.)

i. Manufacturer's TSO qualification test report.

j. Nameplate drawing with the information required by paragraph **4** of this TSO.

k. List of all drawings and processes (including revision level) that define the article's design. For a minor change, follow the directions in 14 CFR § 21.611(a). Show any revisions to the drawing only on our request.

l. An environmental qualification form describing the environmental tests that were conducted in accordance with paragraph **3.c** of this TSO, appendix 1, and SAE AS408C.

m. If the fuel, oil and hydraulic aircraft pressure instrument includes a digital computer: a plan for software aspects of certification (PSAC), software configuration index, and software accomplishment summary. We recommend that you submit the PSAC early in the software development process. Early submittal allows us to resolve issues, such as partitioning and determination of software levels.

(1) All data supporting the objectives found in RTCA/DO-178B Annex A, Process Objectives and Outputs by Software Level, must be available for review.

(2) You must substantiate software levels in the safety assessment process outlined in RTCA/DO-178B or the most current revision. If the equipment incorporates more than one software level, we require appropriate partitioning of different software levels.

n. If the fuel, oil and hydraulic aircraft pressure instrument includes a complex custom micro-coded component: plan for hardware aspects of certification (PHAC), hardware verification plan, top-level drawing, and hardware accomplishment summary. We recommend that you submit the PHAC early in the software development process. Early submittal allows us to quickly resolve issues.

6. <u>MANUFACTURER DATA REQUIREMENTS</u>. Besides the data given directly to us, have the following technical data available for review by the responsible ACO or civil aviation authority:

a. The functional qualification specifications for qualifying each production article to ensure compliance with this TSO.

b. Equipment calibration procedures.

c. Corrective maintenance procedures within 12 months after TSO authorization.

d. Schematic drawings.

e. Wiring diagrams.

f. Material and process specifications.

g. Results of environmental qualification tests conducted per appendix 1 of this TSO, and SAE AS408C (or most current revision).

h. If the fuel, oil and hydraulic aircraft pressure instrument includes a digital computer, the appropriate documentation defined in RTCA/DO-178B, including all data supporting the objectives found in Annex A, Process Objectives and Outputs by Software Level, must be available for review.

i. If the fuel, oil and hydraulic aircraft pressure instrument includes a complex custom micro-coded component, the appropriate hardware life cycle data combined with design assurance level, as defined in RTCA/DO-254 (or most current revision), Appendix A TableA-1.

7. FURNISHED DATA REQUIREMENTS. If furnishing one or more pressure instruments manufactured under this TSO to one entity (such as an operator or repair station), send one copy of the data specified in paragraphs **5.a** through **5.h** to each entity. Add any other data needed for the proper installation, certification, use, or for continued airworthiness, of the instruments.

8. HOW TO GET REFERENCED DOCUMENTS.

a. Order SAE documents from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001. Telephone (724) 776-4970, fax (724) 776-0790. You can also order copies through the SAE website at www.sae.org.

b. Order RTCA documents from RTCA Inc., 1828 L Street NW, Suite 805, Washington, D.C. 20036. Telephone (202) 833-0330, fax (202) 833-9434. You can also order copies on the RTCA website at www.rtca.org.

c. Order copies of 14 CFR, parts from the Superintendent of Documents, Government Printing Office, P.O. Box 37154, Pittsburgh, PA 15250-7954. You can order copies through the Government Printing Office website at www.access.gpo. Select “Access” then “Online Bookstore.” Select “Aviation,” then “Code of Federal Regulations.”

d. You can find a current list of technical standard orders on the FAA Internet website Regulatory and Guidance Library at www.airweb.faa.gov/rgl. You will also find advisory circulars and the TSO Index of Articles at the same site.

/S/ David W. Hempe

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APPENDIX 1. MINIMUM PERFORMANCE STANDARDS (MPS) FOR PRESSURE INSTRUMENTS - FUEL, OIL, AND HYDRAULIC

1. This appendix lists FAA modifications to the MPS for fuel, oil and hydraulic pressure instruments. The MPS applying to this TSO are in SAE AS408C, *Pressure Instruments - Fuel, Oil, and Hydraulic*, dated July 1, 2001, except for paragraphs 3.1, 3.1.1, 3.1.2, and 3.2.b.

AS408C	***FAA modification:***
Title	Replace "Pressure Instruments – Fuel, Oil, and Hydraulic (Reciprocating Engine Powered Aircraft)" Substitute: "Pressure Instruments – Fuel, Oil, and Hydraulic"
Section 1.1	Replace "…primarily for use with reciprocating engine powered transport aircraft, …" Substitute: "…for use with civil aircraft,..."

AS408C section 7	***FAA modification:***
Para 7.13	Use test conditions in SAE AS1055 Rev D, Fire Testing of Flexible Hose, Tube Assemblies, Coils, Fittings, and Similar System Components, dated June 1, 1997, Sections 4 and 5.
Para 7.14	Add test conditions in RTCA/DO-160E, Section 16, Power Input.
Para 7.15	Add test conditions in RTCA/DO-160E Section 17, Voltage Spike.
Para 7.16	Add test conditions in RTCA/DO-160E Section 18, Audio Frequency Conducted Susceptibility – Power Inputs.
Para 7.17	Add test conditions in RTCA/DO-160E Section 19, Induced Signal Susceptibility
Para 7.18	Add test conditions in RTCA/DO-160E Section 20, Radio Frequency Susceptibility.

2. You can enhance the performance of fuel, oil and hydraulic pressure instruments, or make them superior to this specification, depending on your intended application and configuration.